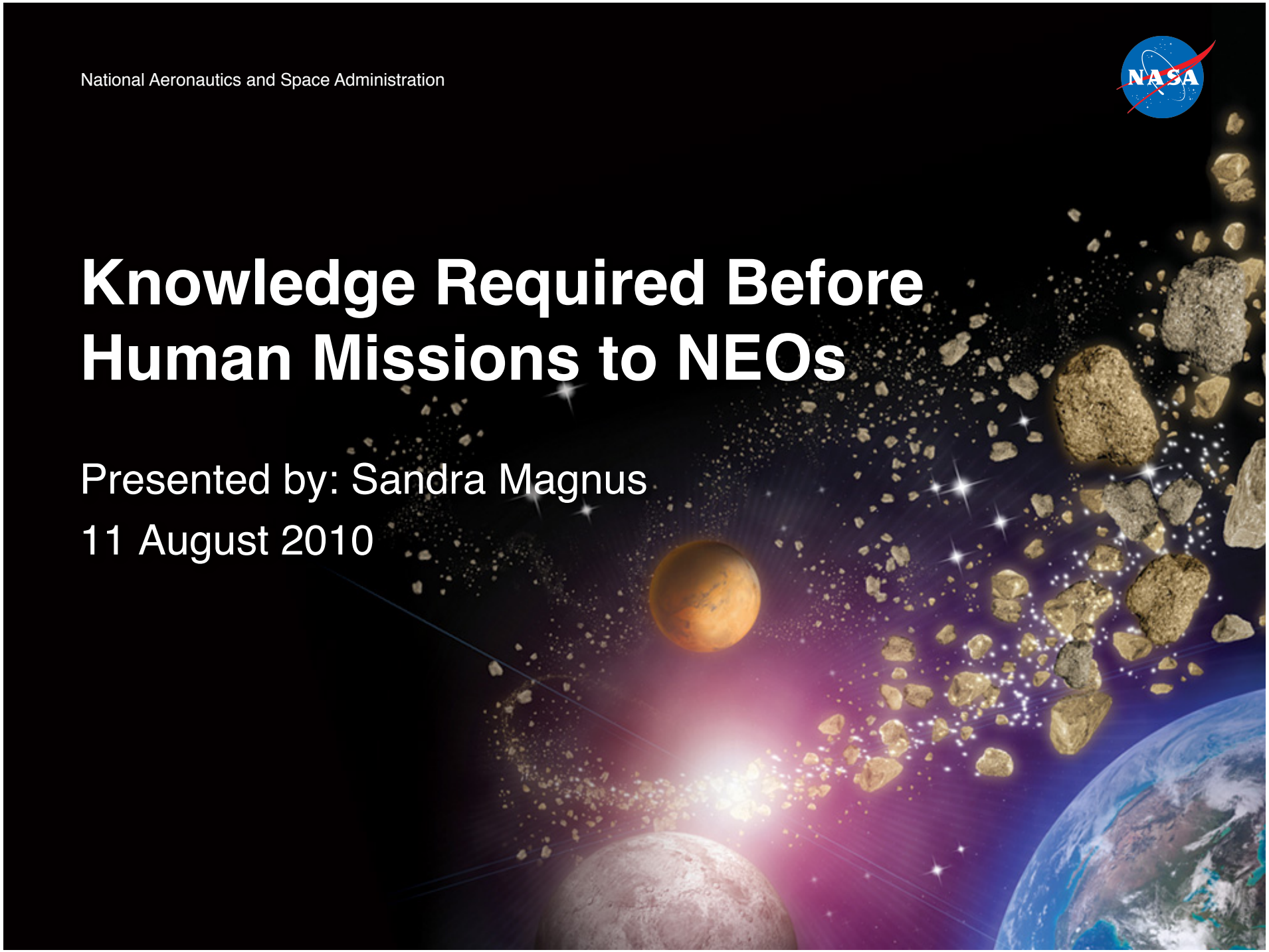
National Aeronautics and Space Administration



Knowledge Required Before Human Missions to NEOs

Presented by: Sandra Magnus

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Magnitude of Findings

Theme	Number of Objectives
Engineering Boundary Conditions	5
Hazards	6
Resources	2
Target Selection	4

- Other observations

Target Selections

Human Objective	Knowledge Gap	Measurement	Need	Notes
Target Selection	Unknown distribution, characteristics and availability of targets	Shape, size Orbits Spin Composition (type) Hazards - Satellites, (binary) IR telescope Brightness visible spectrum measurements rotation rate pole orientation	Critical	Early
Target Selection	Knowledge necessary to choose (tools, etc.): Relationship between spectral type and the structure and chemistry of the target?	Same as gravity field & spin state	Critical	

* Need to address what is used as parameters for the filter
* Ground-based measurements should complement precursor measurements

Hazards

Human Objective	Knowledge Gap	Measurement	Need	Notes
Interaction with the NEO	Surface composition, structure, and morphology	* penetration resistance * cohesion * toxicity * shear strength * relative density * temperature		
Target Selection	Gravity field & Spin state / Debris & satellites	Laser Range Finder, Pictures, shape, orbit, Deep Space Network, Mass needs to be close	Critical	
EVA	Structural stability (especially for small bodies) - Safety Issue Uncertain/Unknown geophysics in microgravity Anchoring Technology	Whack it, geo-physical experiments, impact tests Test a number of different approaches	Critical	

Engineering Boundary Conditions

Human Objective	Knowledge Gap	Measurement	Need	Notes
Deflection	Internal Structure	geo-physics, radar, density and porosity,	Nice to have Critical for Planetary Defense	
EVA	Rendezvous and proximity operations	demonstrations on a spinner	critical	
EVA	What are the regolith mechanical properties of the asteroid? Tools & Interaction Strength properties of surface to enable the design of tools for exploring the body.	Sample return, high resolution imaging, radar measurements, geo-technical measurements	critical for surface systems	
EVA	What are the dust properties?	Size, shape, composition, attachment properties, electrical, charge, magnetic	critical	

Resources

Human Objective	Knowledge Gap	Measurement	Need	Notes
Sample collection	Material handling	* sorting by size * magnetic properties * cohesiveness * "free fall" effects		
	Instrument installation	* mineralogy (APXS, GRS) - minimum needed (for determining if ISRU is feasible) * "OH" feature, spectra * H abundance, n. spectra (neutron) * volatiles (water)		

Summary

- Most of the input collected was driven by the need to know what are the physical characteristics and environment of the specific NEO that will be visited
- Identified concern that without knowing the specific objectives of the human mission, it's hard to prioritize knowledge gaps
  - Created a laundry list that has not been finalized to enable prioritization
- Need to have a discussion about what is the minimum knowledge required to enable human NEO visits